Interreg
Danube Transnational Programme
DriDanube

Drought Risk Assessment
in DriDanube project

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Presentation overview

Concepts of risk assessment

Drought risk assessment: impacts vs. hazard

-> Presentation of ZT method

DriDanube output: RED software & related maps

Definition of risk – understanding drought risk

Risk is a combination of the consequences of an event (hazard) and the associated likelihood/probability of its occurrence. (ISO 31010)

Risk = probability of occurrence **X** degree of impact (cost/consequences)
(According to the EU Civil Protection mechanism)

Risk is expected loss due to (natural) disasters per unit time

Disaster risk reduction (DRR) approach of risk assessments

Risk =f (hazard x *exposure* x vulnerability)

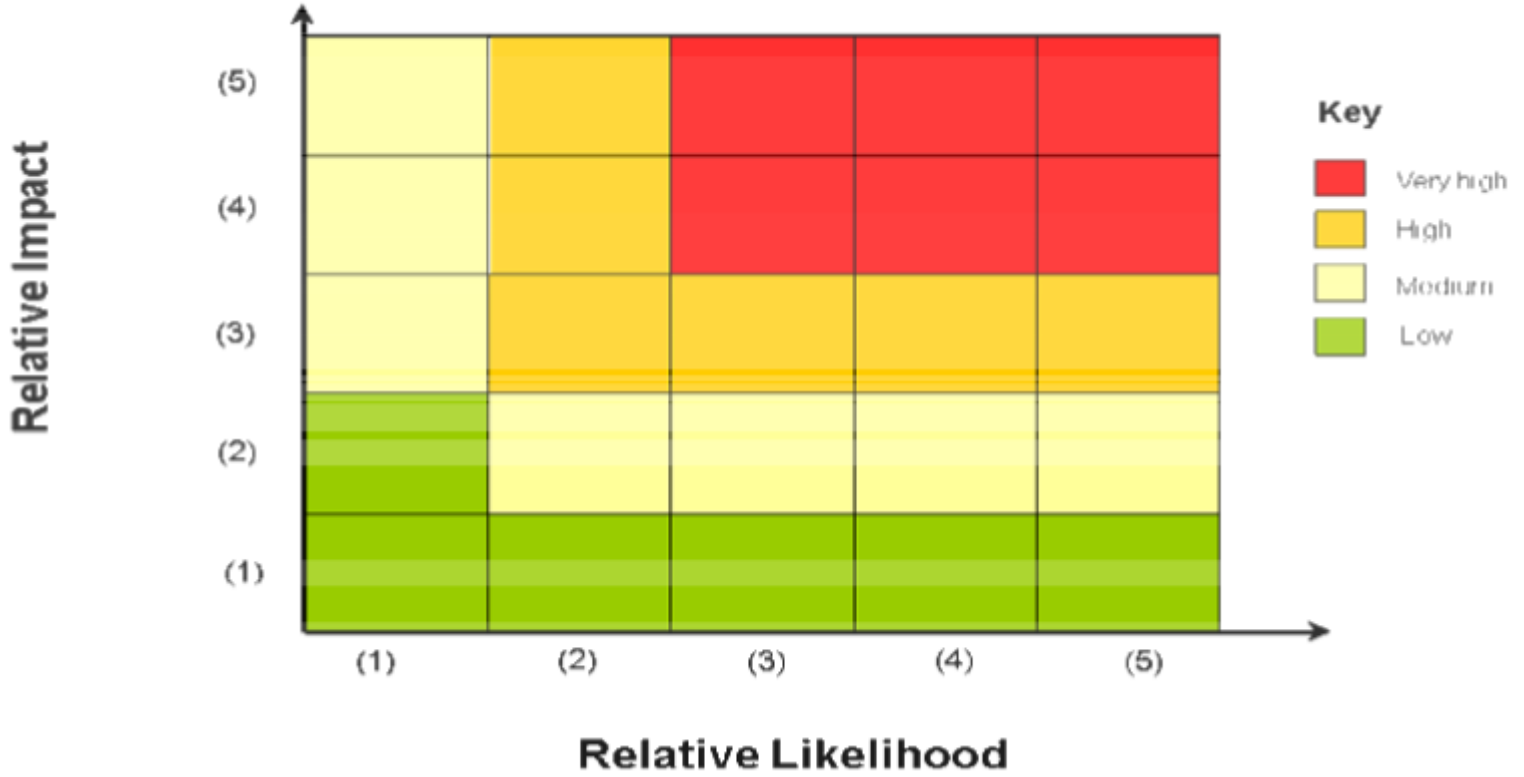
Climate change adaptation(CCA) approach of risk assessment

Important that drought risk is not: frequency and severity of the hazard (*Veit Blauhut, 2018*).

We followed the recommendations of EU Civil Protection mechanism which is DRR impact-base approch.
Risk is defined as the expected value of the loss function.
In our development we focused on agricultural drought because we had impact data mainly from agriculture

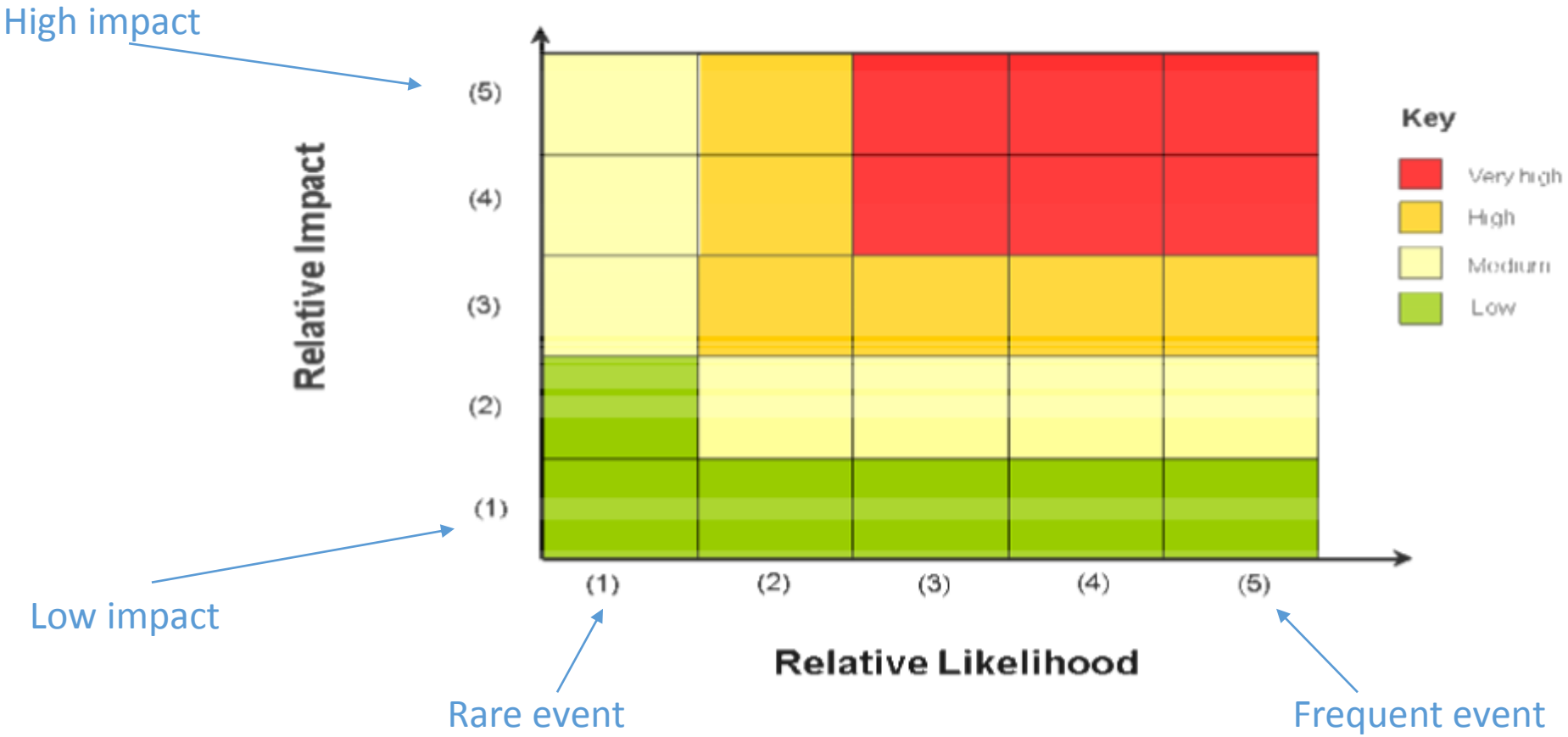
Definition of risk

Due to its „two component nature“, the risk is often presented in form of the matrix, where the horizontal axis shows the probability of occurrence of drought, the vertical axis shows the relative impacts (relative yield losses) and the colors shows the risk value categories. So the risk is the expected losses in % in the different probability of drought.

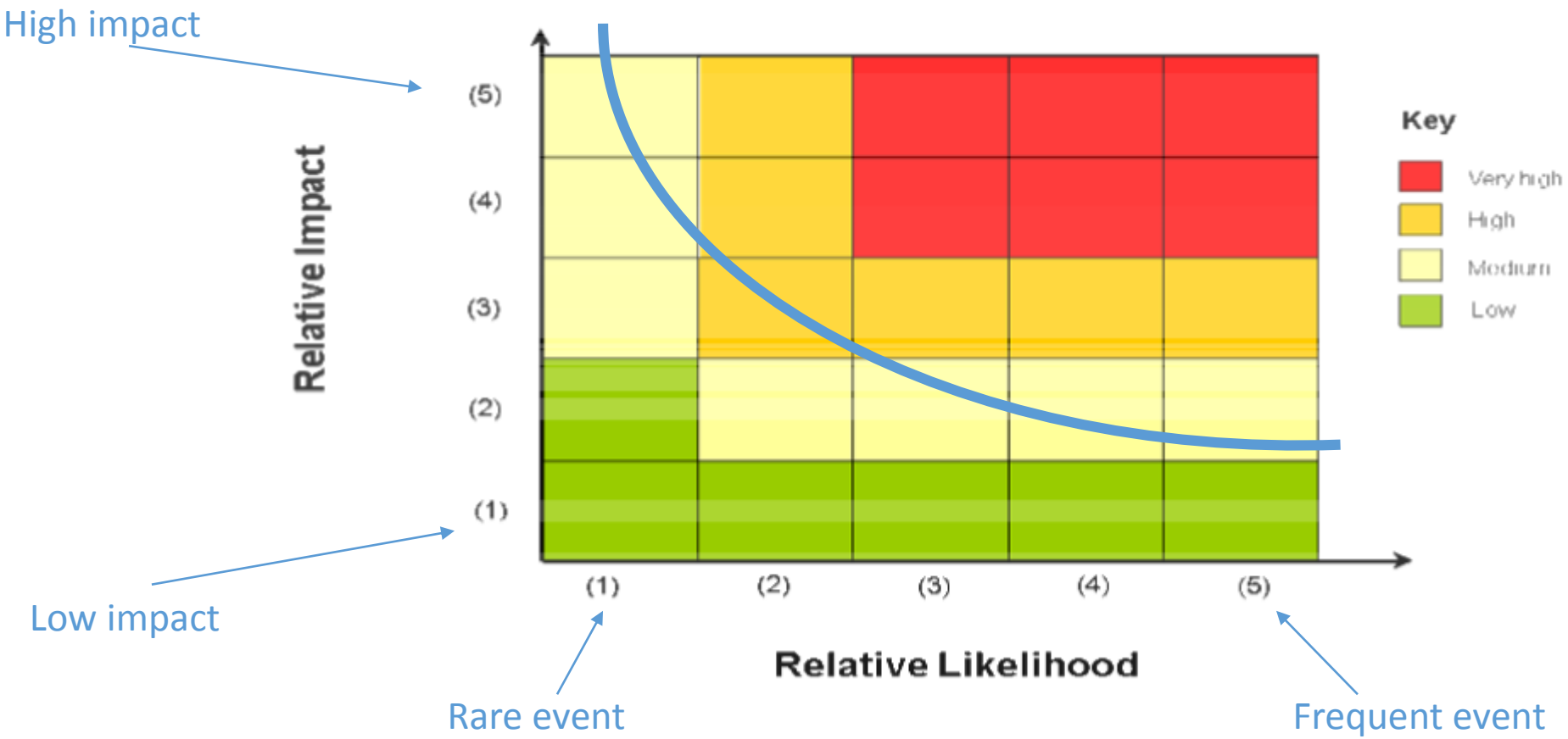


Source: https://ec.europa.eu/echo/files/about/COMM_PDF_SEC_2010_1626_F_staff_working_document_en.pdf

Definition of risk

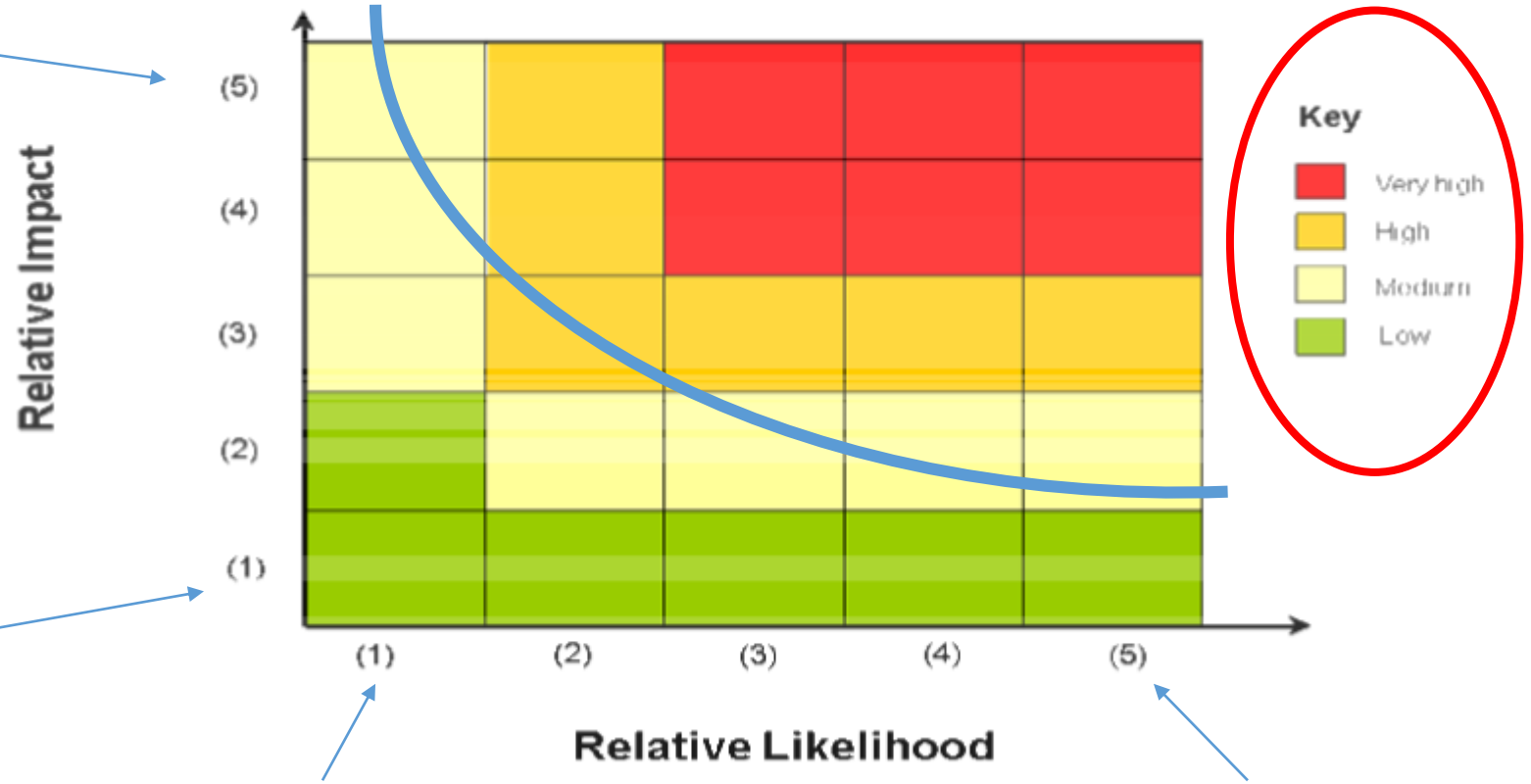


Definition of risk



Definition of risk

High impact



Low impact

Rare event

Frequent event

IMPORTANT!
Classess (and color scales) are sector-specific and most often subjective!

Hazard

- „Natural“ component of risk
- Identify Drought: common approach is to use drought indices
  - e.g. SPI (Standardized Precipitation Index)

SPI	Category	Number of times in 100 years	Severity of event
0 to -0.99	Mild dryness	33	1 in 3 yrs.
-1.00 to -1.49	Moderate dryness	10	1 in 10 yrs.
-1.5 to -1.99	Severe dryness	5	1 in 20 yrs.
< -2.0	Extreme dryness	2.5	1 in 50 yrs.

Source: http://www.wamis.org/agm/pubs/SPI/WMO_1090_EN.pdf

Hazard

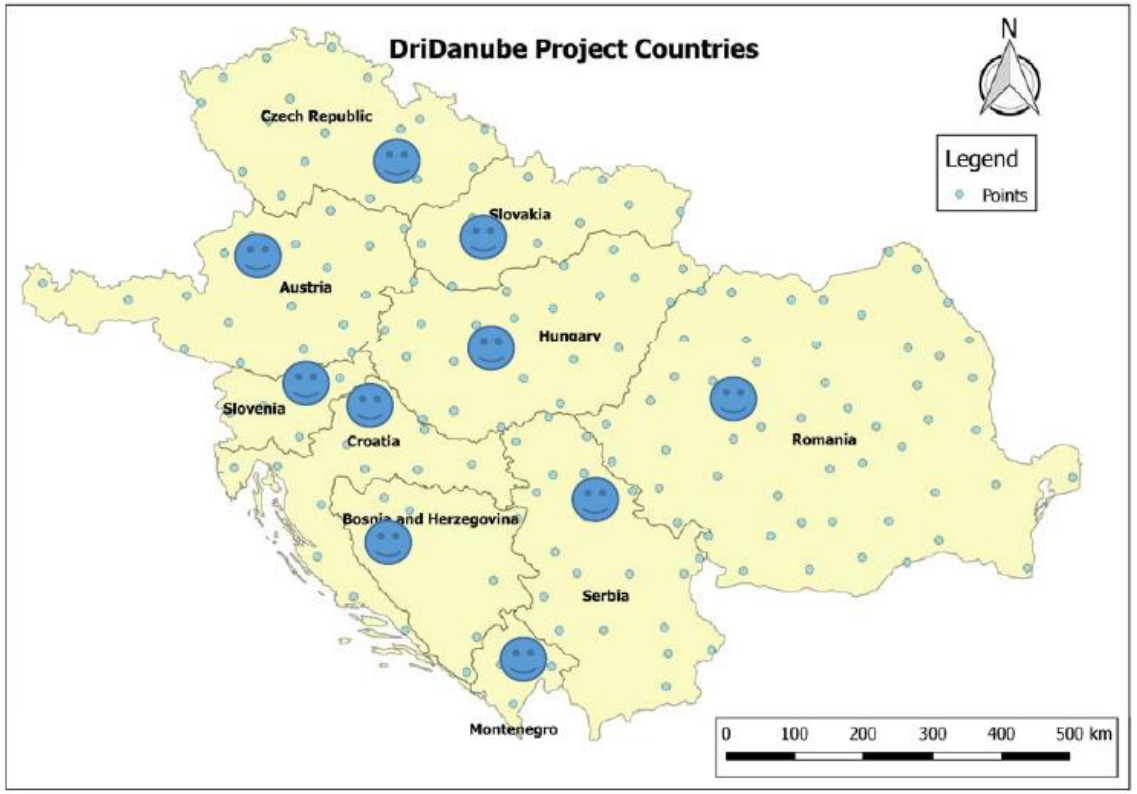
- Analysis of extreme rainless periods (droughts) as approach to drought hazard based on

  ZT method (after Zelenhasic and Todorovic). Main features of the ZT method :

  - it is a general stochastic model of extreme rainless events (droughts) at certain location;
  - drought is defined as at least 20 consecutive days long period with less than 3 mm of daily rainfall;
  - droughts are independent events, represented by identically distributed random variables that follow the Poisson probability law;
  - method considers all important components of the process - drought duration, time of the occurrence, number of droughts in a given time interval [0,t], and the duration of the
  - longest drought in a given time interval [0,t];
  - method provides return periods of the longest droughts, i.e. probability of longest drought occurrence;
  - application of the ZT method for the vegetation season - starting on 1st April and ending on 30th September.

Hazard

- Analysis of extreme rainless periods (droughts) as approach to drought hazard based on **ZT method (after Zelenhasic and Todorovic).** Available data : 170 points over the region

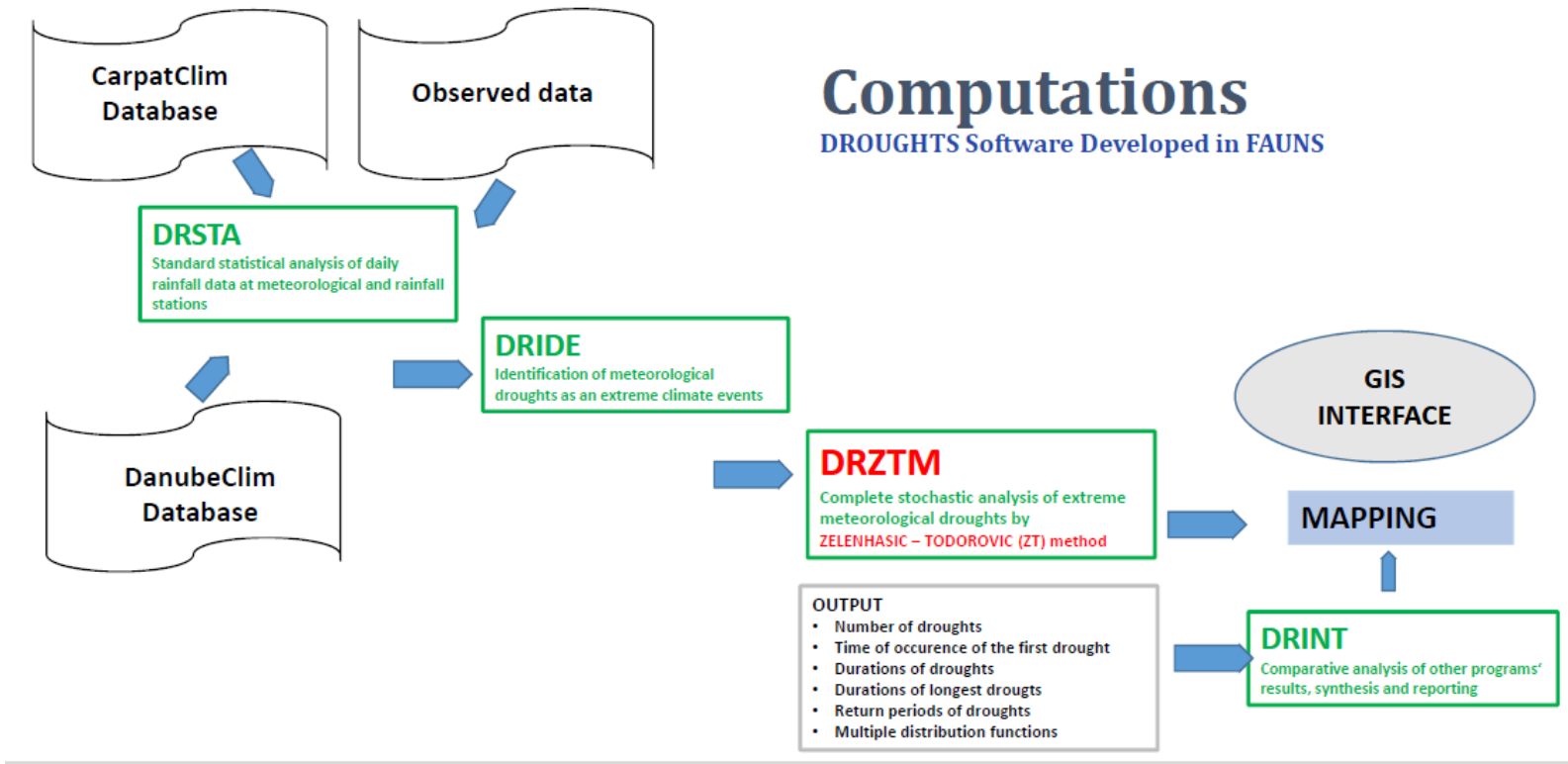


Daily raiinfall data (1981-2010).

Partner country	Number of points	Source of daily rainfall data
Austria	19	Missing information
Bosnia and Herzegovina	6	DanubeClim
Czech Republic	17	Missing information
Croatia	12	Observed data
Hungary	22	CarpatClim + DanubeClim
Montenegro	4	DanubeClim
Romania	43	CarpatClim
Serbia	20	CarpatClim + DanubeClim
Slovakia	22	CarpatClim
Slovenia	5	Observed data

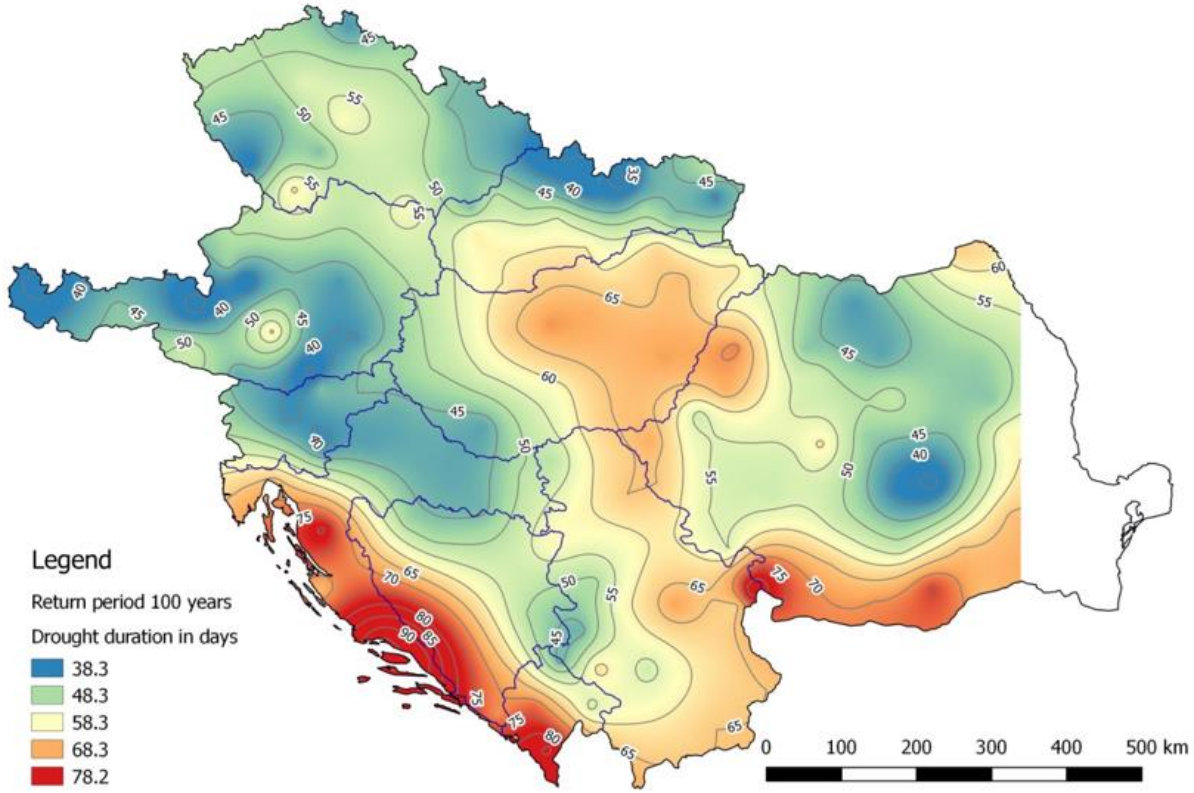
Hazard

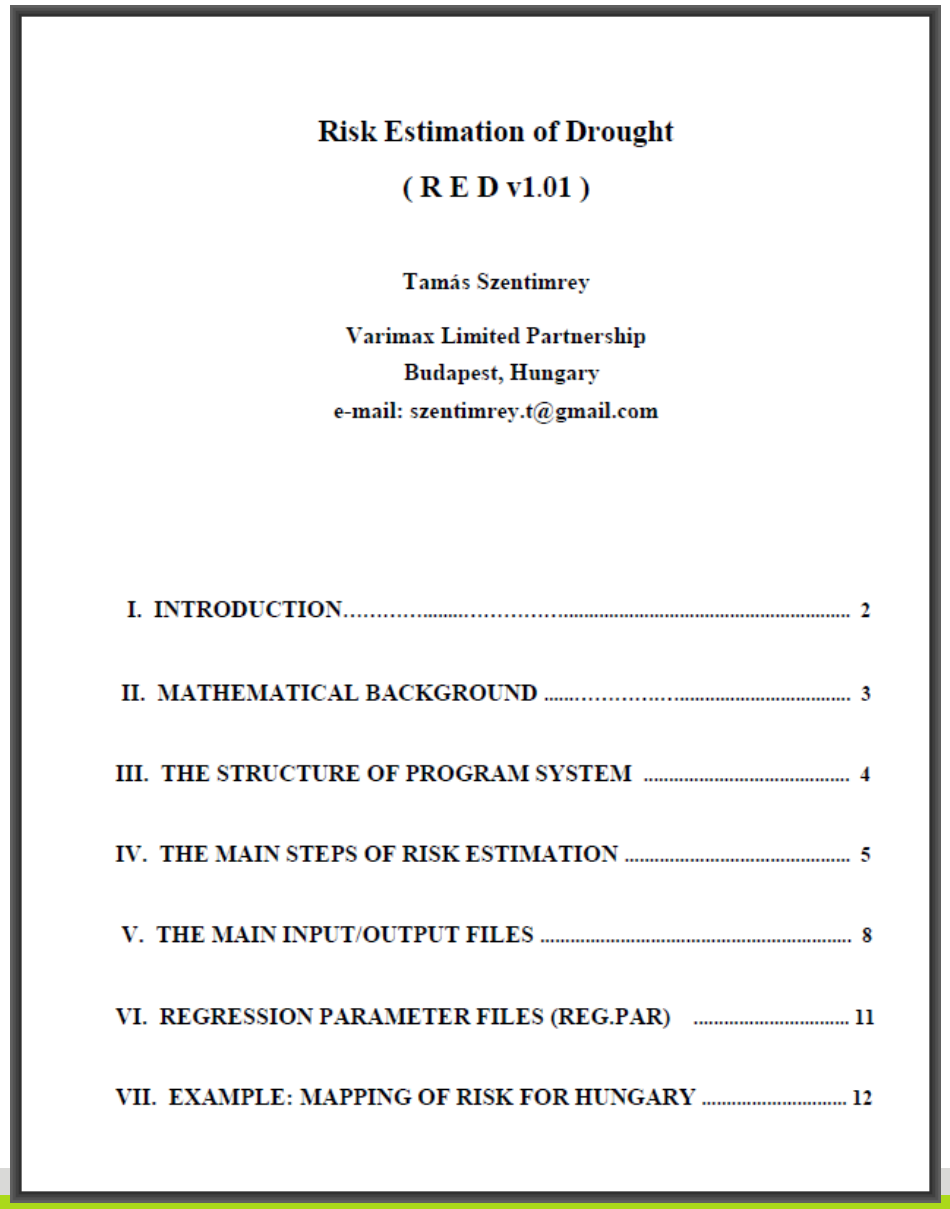
- Analysis of extreme rainless periods (droughts) as approach to drought hazard based on **ZT method (after Zelenhasic and Todorovic).** Computation procedure:



Hazard

- Analysis of extreme rainless periods (droughts) as approach to drought hazard based on **ZT method (after Zelenhasic and Todorovic).** Example of result:





Risk Estimation of Drought

(R E D v1.01)

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Project output:

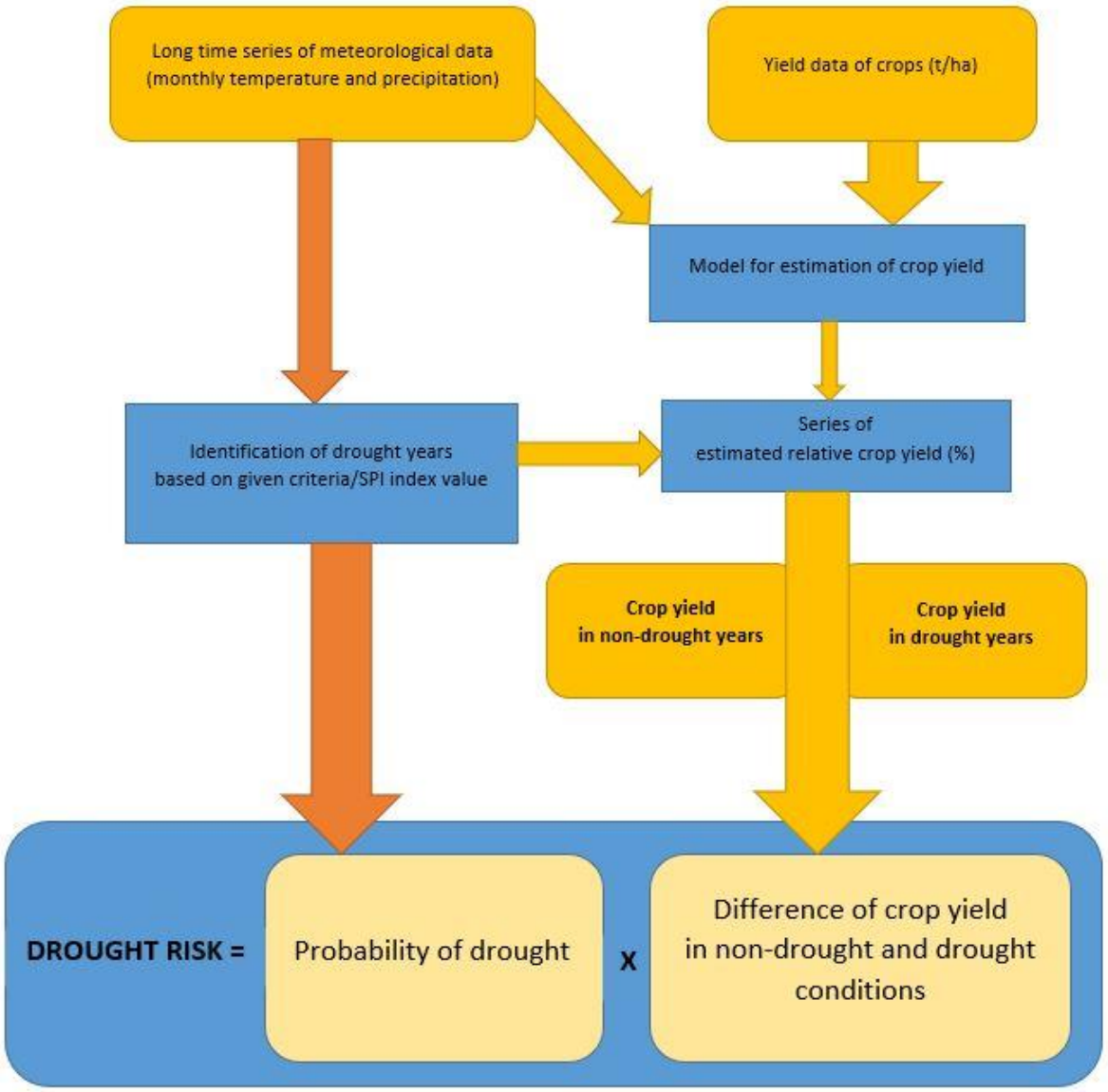
RED (Risk Estimation of Drought) software package

- ✓ Freely available on the following link: https://www.met.hu/downloads.php?id=16&file=REDv1.01 .
- ✓ The developed drought risk assessment based on Disaster risk reduction (DRR) approach of risk assessments (not the Climate Change Adoption (CCA) approach which use hazard-exposure – vulnerability conseption to define risk).
- ✓ The developed algorithm give priority to quantify negativ impact of drought on yield of the different crops. So the drought risk assessment type is impact-based statistical risk assessment which used yield of crops (t/ha) to estimate expected losses (%) due to drought .

Impacts of meteorological variables on yield

Input to **RED** software:

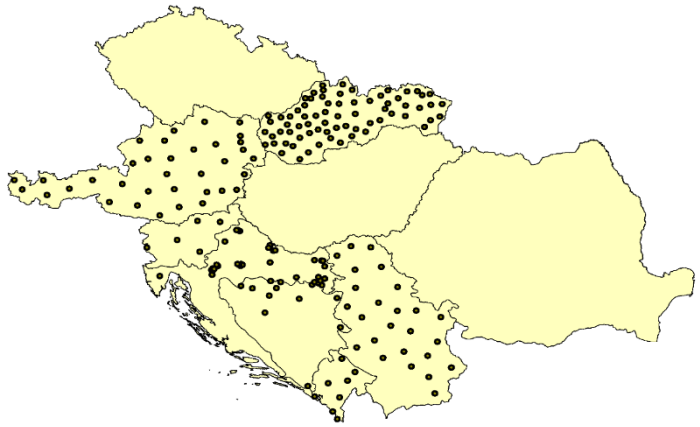
- **Meteorological data** (monthly temperature and precipitation) for a long period
- In the countries of DriDanube area we used griddinged meteorological variables between **1961 and 2010** from **Carpatclim**, Danubeclim (*Szalai et al., 2013*) and **E-OBS** (v17.0) (*Haylock et al, 2018*) database.

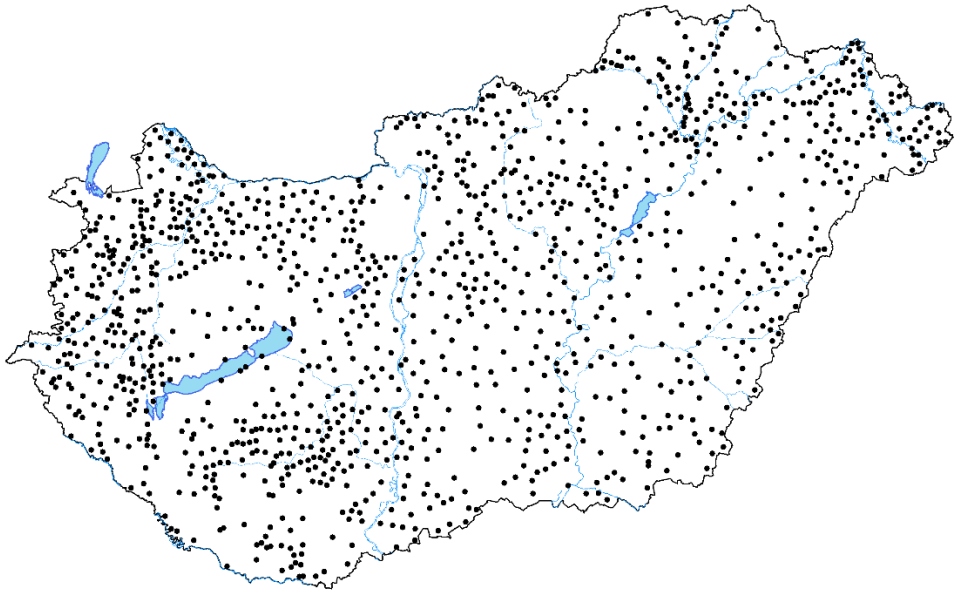


Impacts without impacts data

Input to **RED** software:

- **Crop yield data** (arbitrary period within meteorological time series)
- To build linear regression model to estimate effect meteorological variables on crop yield we used the European Commission Farm Accountancy Data Network (FADN) yield datasets and other provided yearly yield data from the DriDanube countries.

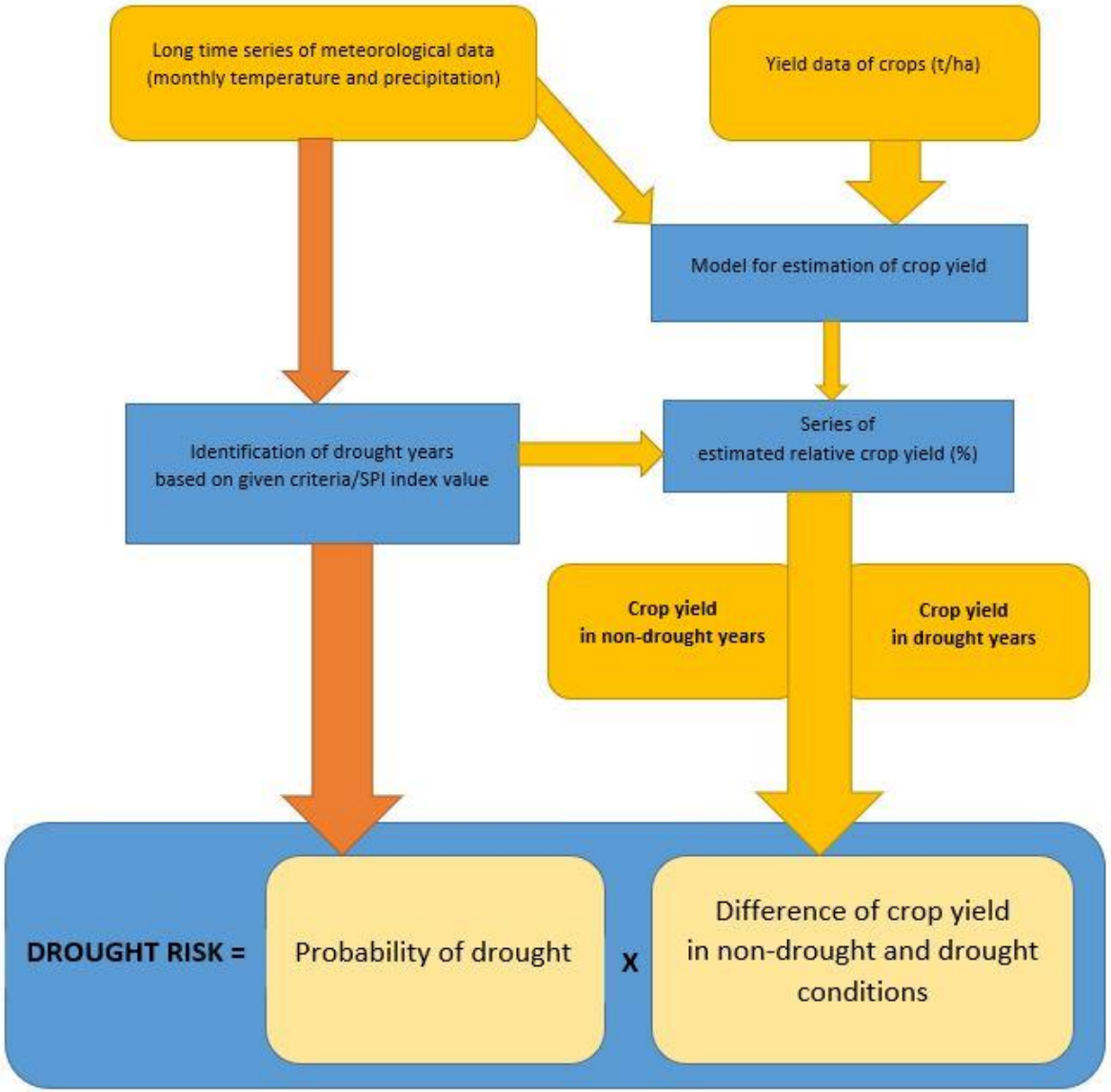




Identification of Drought

To Risk calculation we need:

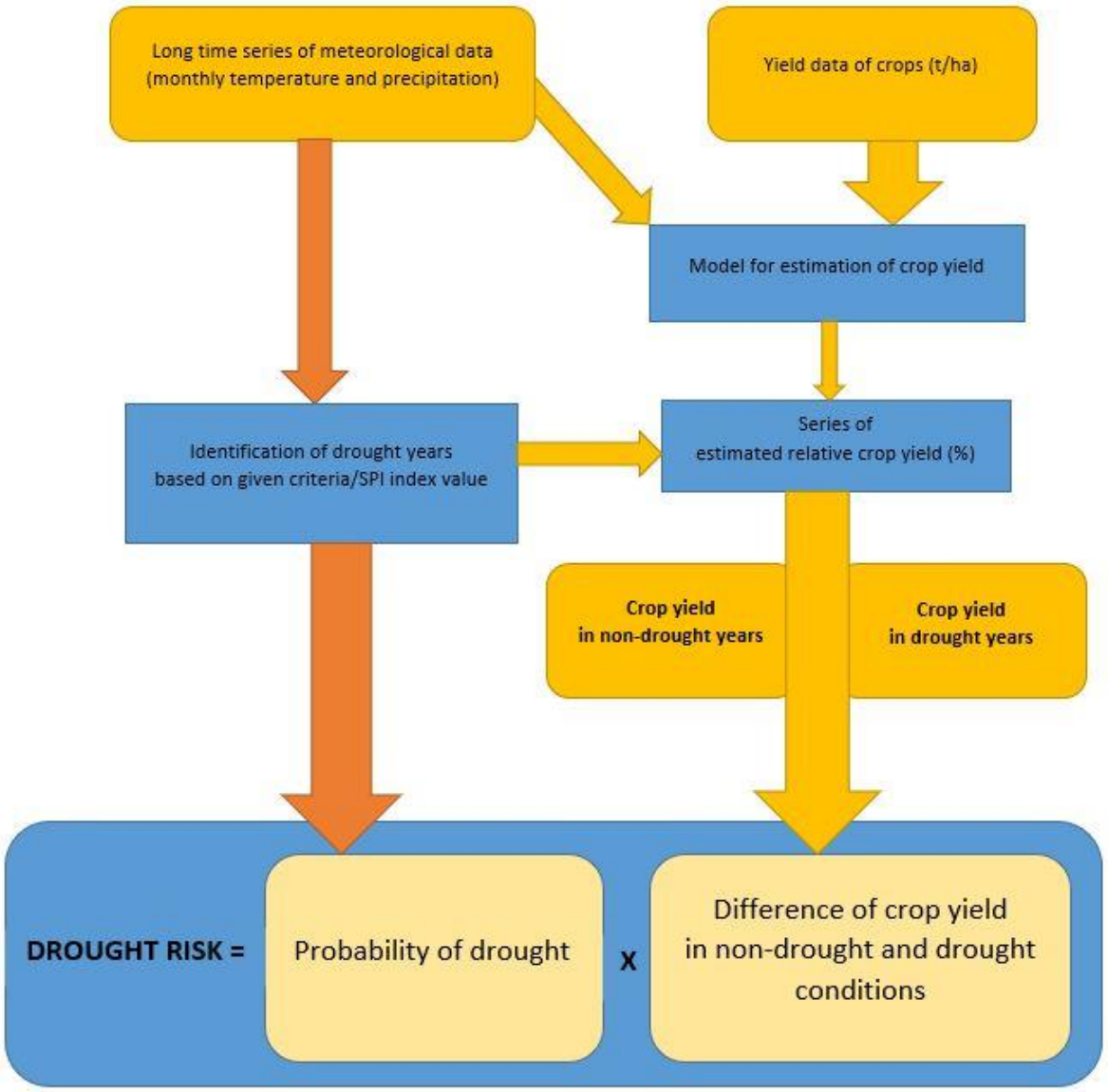
- Separation of years in time series to non-drought /drought years based on chosen drought indicator as SPI.
- We found higher correlation between crop yield and SPI:
  - For barley with SPI3 in April
  - For maize with SPI3 in July
  - For rape with SPI3 in April
  - For wheat with SPI6 in June.



Risk estimation

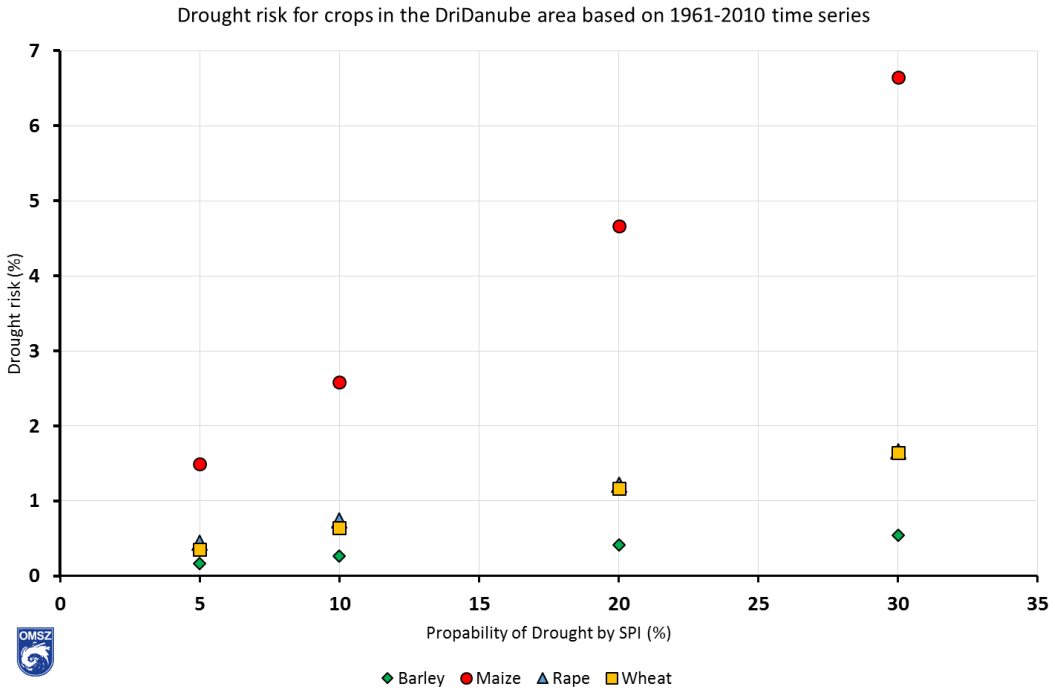
To Risk calculation finaly we need:

- Difference of relative **crop yield** in both cathegories (non-drought year and drought year)
- multiplied by probability of occurence,
- which is the **expected value of loss due to drought or drought risk in %.**

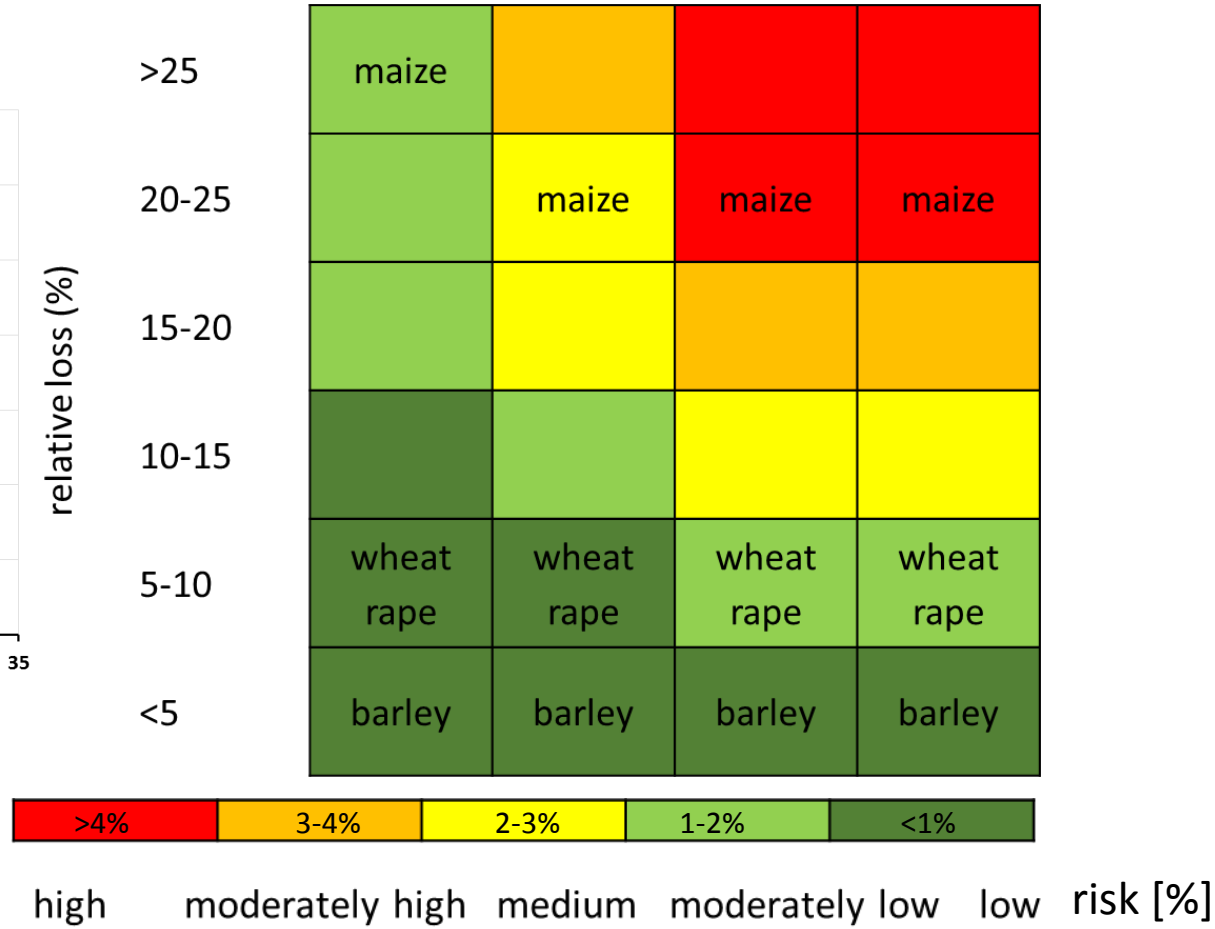


Results: Drought risk in % in DriDanube Area

Drought risk for main crops



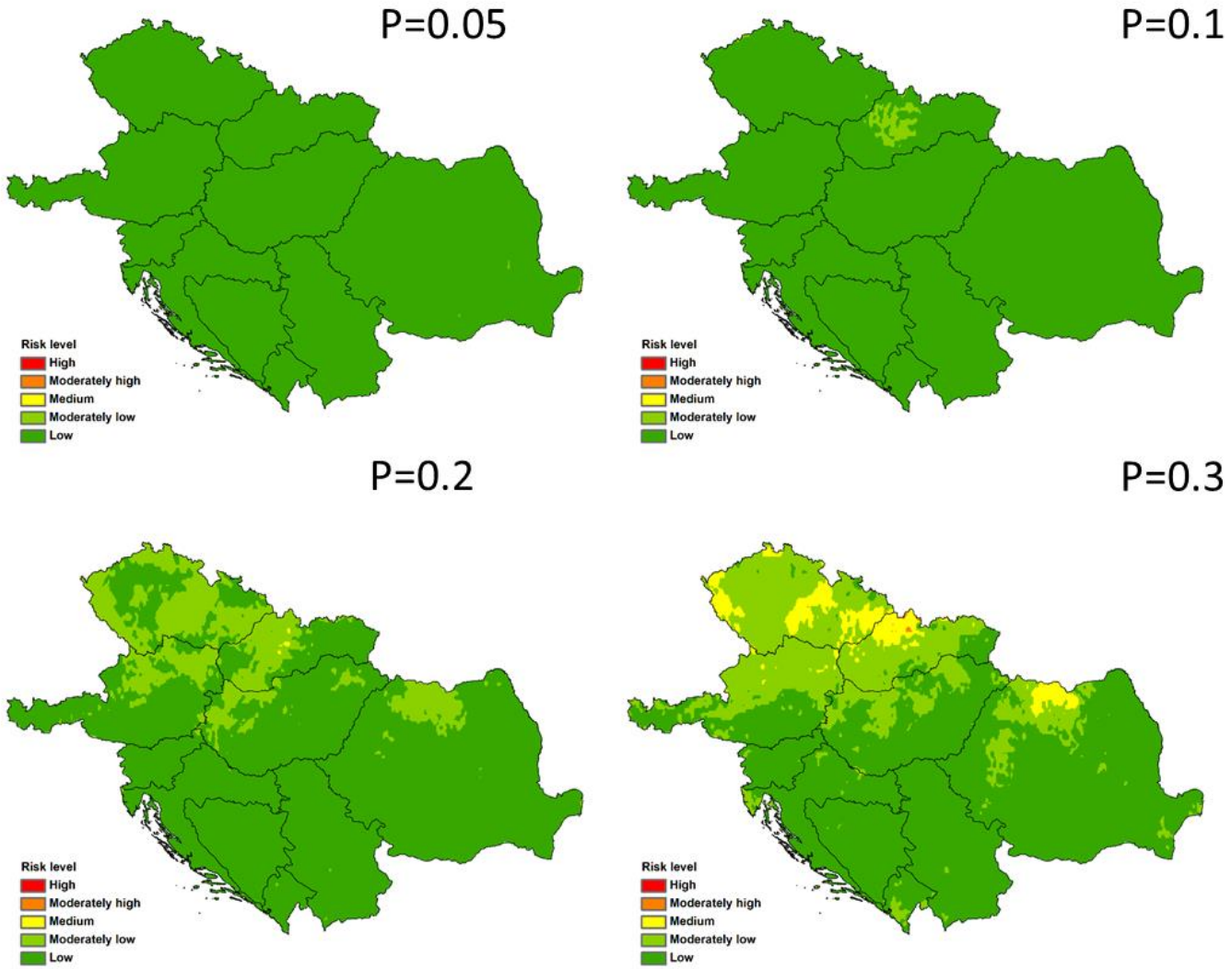
Risk matrix



Results

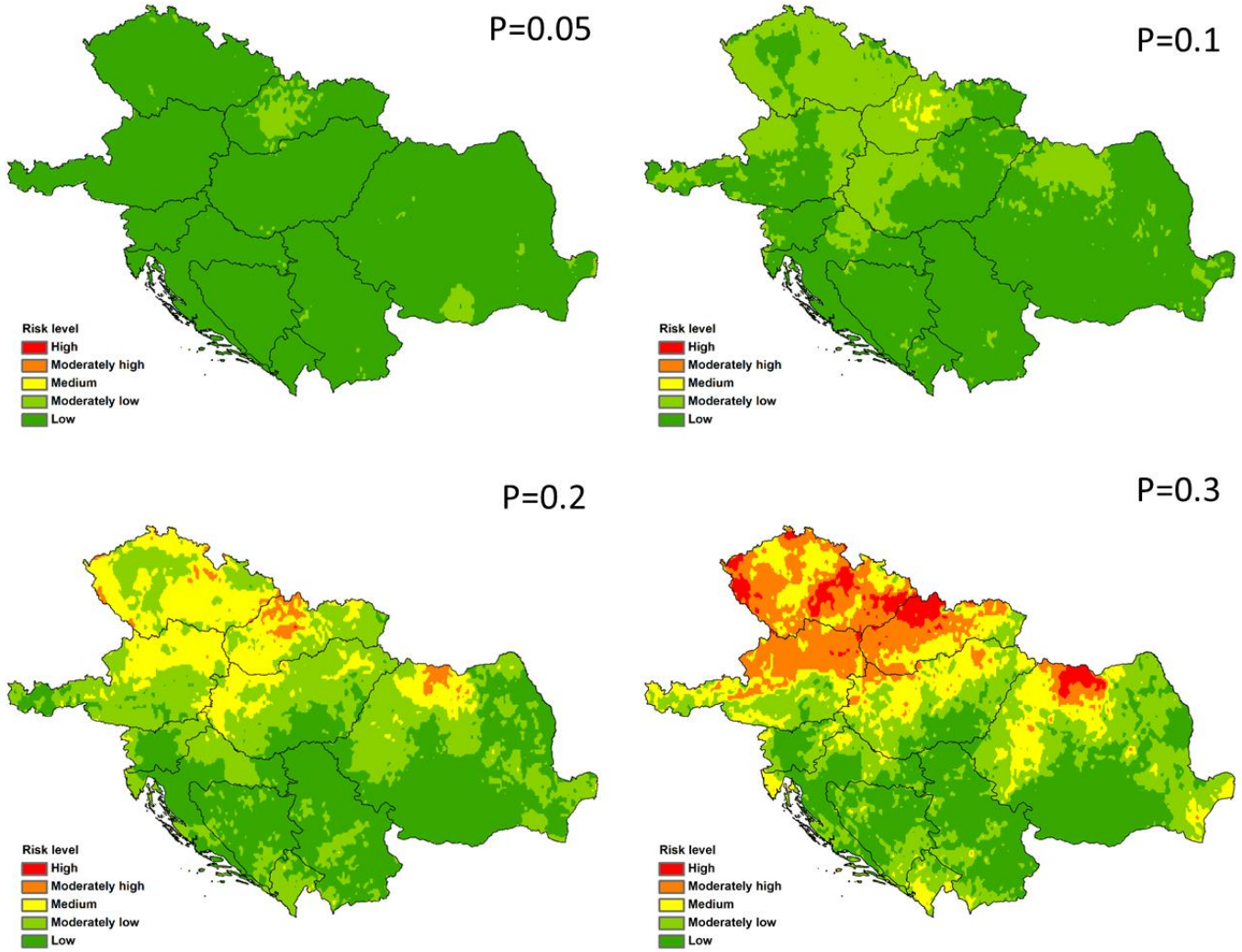
Risk maps for barley on different droght probability levels (P)

You can see the spatial distribution of drought risk (expected losses) in % for more than 9000 point.



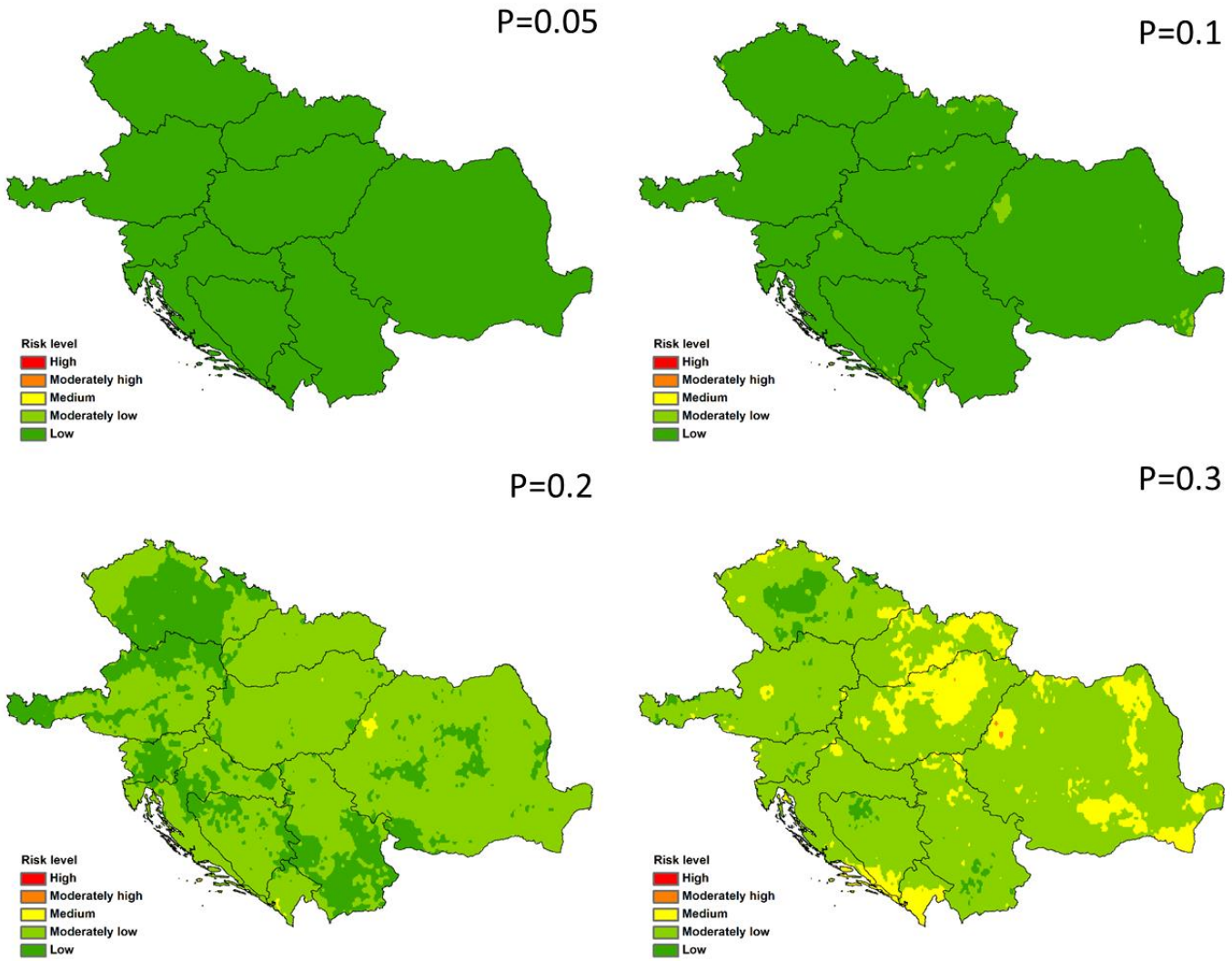
Results

Risk maps for rape on different droght probability levels (P)



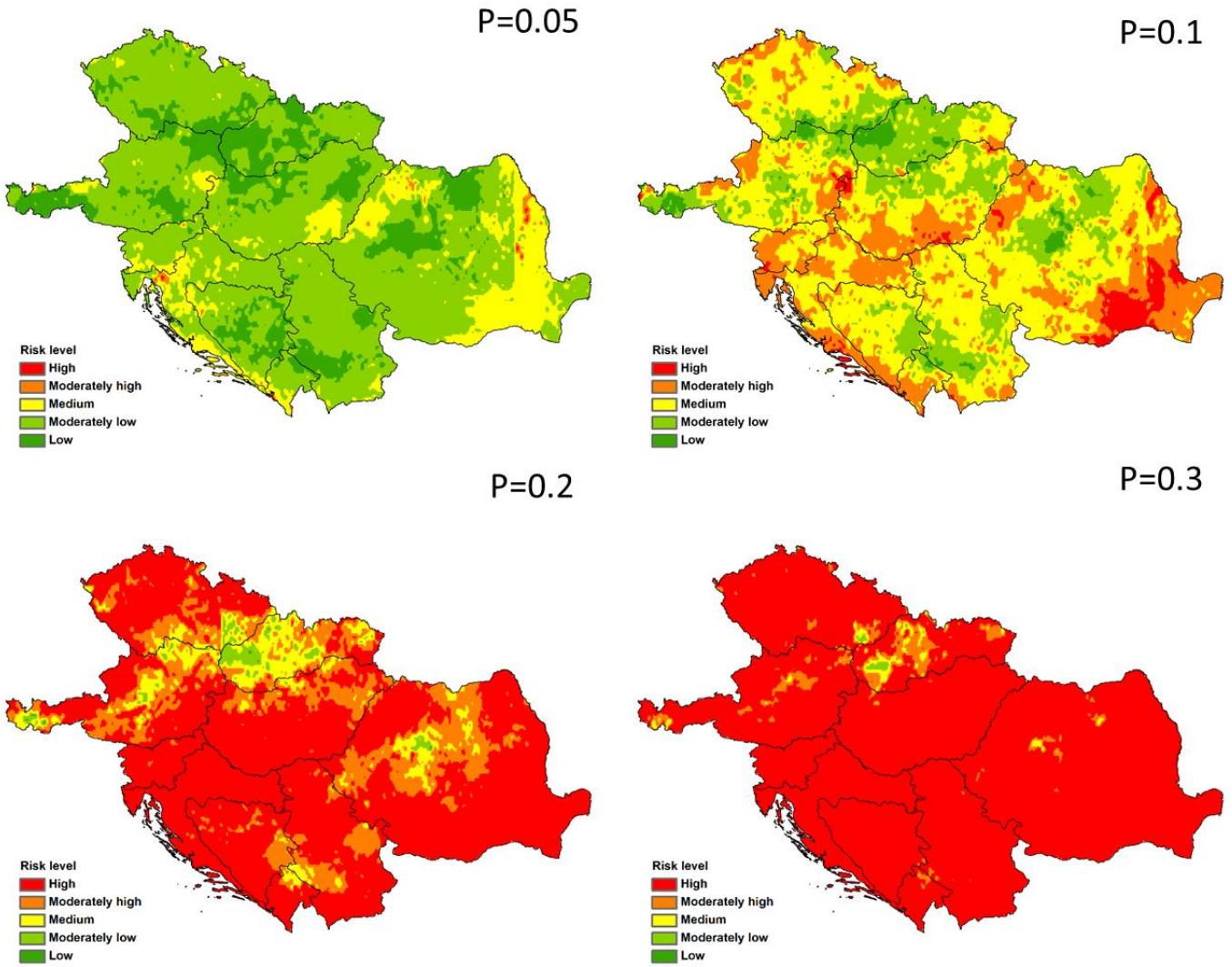
Results

Risk maps for wheat on different droght probability levels (P)



Results

Risk maps for maize on different droght probability levels (P)



Points for discussion

Do you prepare own risk assessments?

– Why, if you can find a detailed drought risk maps for main crops of your country area in the www.droughtwach.eu ! You can concentrate to reduce lossess due to drought!

If not, do you think that presented procedure could be useful for you?

- The qualitative approch give an objective analysis of drought risk and quantify expected losses in crop yield. The algorithm and the RED software give an opportunity to change drought identification method or you can use modeled crop yield to calculate drought risk in the future, too.

Do you find matrix-type of risk assessment presentation clear and understandable?

- My opinion is that the matrix-type visualize of drought risk do not help to understanding drought risk.

Do you have suggestions for color scale?

-The risk categories depend on your aims. If you like to see more high risk area, you need to change the categories. Now the high drought risk category (red) start above 4% expected losses on crop yield due to drought.